## Prognostic factors for low back pain in patients referred for physiotherapy: comparing outcomes and varying modeling techniques

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# Prognostic Factors for Low Back Pain in Patients Referred for Physiotherapy

## Comparing Outcomes and Varying Modeling Techniques

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**Study Design.** Data were derived from a randomized controlled trial on the (cost-) effectiveness of the implementation of the clinical guidelines on physiotherapy for low back pain in primary care.

**Objectives.** To describe the course of low back pain in patients who are referred to physiotherapy, to identify clinically important prognostic factors on different outcomes, and to evaluate the influence of different statistical techniques in developing a prognostic model.

**Summary of Background Data.** Several studies have aimed to identify prognostic factors for low back pain in primary care. These studies focused on different outcome measures and used various statistical techniques.

**Methods.** Primary outcomes were perceived recovery, improvement in pain, improvement in functioning, and presence of disabling low back pain at 3 and 12 months follow-up. Multivariate logistic regression analyses were performed for each outcome variable. Two cut-off points were used to determine significance with respect to the univariate analysis, and two selection methods were used to build the final multivariate models. The resulting prognostic models were compared.

**Results.** A total of 500 patients were included. Pain and disability reduced considerably in the first 3 months, but further reduction was only modest. Prognostic factors varied for different outcomes, but the duration of the current episode was included in all models generated. Varying the statistical techniques also resulted in a different prognostic model with some change to the amount of variance explained.

**Conclusions.** A substantial proportion of patients still experienced some pain and disability at 12 months follow-up. The most stable predictor of prognosis in low back pain was the duration of the current episode. The choice of statistical method influenced the final model; however, changes in the explained variance were small.

**Key words:** prognosis, low back pain, outcome, epidemiology, primary care, physiotherapy. **Spine 2005;30: 1881–1886**

Low back pain is considered to be a benign disorder with a good prognosis. However, the results of recent reviews suggest that the long-term course on pain or functional recovery is not so favorable and that low back pain does not usually resolve spontaneously when ignored.[1,2] Low back pain is a substantial economic burden on society, because of the high costs attributed with sick-leave and disablement.[3] As a small percentage of patients with chronic low back pain accounts for a large portion of the costs,[4] it would be useful for both clinicians and patients to be able to predict the prognosis of low back pain at an early stage.

Several other reviews summarized the results of prognostic studies of low back pain.[2,5–7] Prognostic factors that have been identified cover the whole spectrum of Waddell's biopsychosocial model of pain and disability.[8] Examples of suspected biologic, psychological, and social prognostic factors are radicular symptoms,[7] distress and somatization,[6] and job dissatisfaction.[5]

Despite the considerable amount of prognostic studies, there is a lack of consistency between their results. This inconsistency has been attributed to the methodological weakness of studies or to the recruitment of an irrelevant cohort.[2] However, it may also be attributed to a large heterogeneity between studies. One of the most important sources of heterogeneity between these studies will relate to difference in outcome measures used and the study populations/settings. In addition, as the studies used different statistical methods, these may also contribute to inconsistent prognostic factors. As long as there is no comprehensive picture of prognostic factors, it will be difficult to target interventions in an optimal way.

Recently, we have conducted an randomized controlled trial (RCT) to evaluate the implementation of clinical guidelines on physiotherapy for low back pain. Participants were patients with low back pain who were referred to the physiotherapist by their general practitioner (GP). The results showed that an active implementation of the guidelines resulted in a higher compliance to

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these guidelines but without improving the patient outcomes compared with a standard method of implementation.[9]

Schiottz-Christensen *et al*[10] showed that the assessment of the GP of a patient's susceptibility to develop chronic low back pain was associated with a poor long-term outcome. Patients who are at risk for chronic low back pain may be more frequently referred to physiotherapy by their GP. Therefore, although the patients of our trial varied in the duration of their current episode, the patients may have a worse outcome and be more homogeneous compared with a general primary care population. As a result, studying such a population generates new opportunities to provide insight in the underlying mechanisms of the development of chronic low back pain.

The objective of this study was to describe the course of low back pain in patients referred to physiotherapy in primary care, to identify prognostic factors for recovery and to analyze the influence of various outcomes and various statistical techniques on development of a prognostic model.

## ■ Materials and Methods

**Study Population.** Physiotherapists from 325 practices in the center of the Netherlands, which were randomly selected from the register of the Royal Dutch Society of Physiotherapy, were sent an invitation to participate in the trial. Eligibility criteria were as follows: working in primary care and expecting to treat at least 5 patients with low back pain within the next 6 months. A total of 113 physiotherapists agreed to participate. The physiotherapists were randomly allocated to receive the guidelines by mail only (control group) or to receive an additional active strategy (intervention group) that consisted of a multifaceted program including education, discussion, role-playing, feedback, and reminders. Subsequently, the physiotherapists included a maximum of 10 patients who had to meet the following criteria: 1) referred for physiotherapy treatment; 2) nonspecific low back pain, confirmed by the physiotherapist; 3) able to complete written questionnaires (in Dutch); 4) not pregnant and not suffering from any severe psychological disorders. The treatment of these patients was left to the discretion of the physiotherapist. The patients completed questionnaires about physical functioning, pain, sick-leave, coping, and back pain beliefs at baseline, and completed the same questionnaires again after 3 and 12 months. Each patient gave written informed consent. The study was approved by the Medical Ethics Committee of the VU University Medical Center in Amsterdam.

**Outcome.** Different types of outcomes at 3 and 12 months follow-up were selected, all of which were dichotomized for the purpose of this study. We used outcomes that are similar to the outcomes used in other prognostic studies on low back pain: perceived recovery,[11] improvement in pain,[12] improvement in functioning,[10] and disabling low back pain.[13] Sick-leave was not considered as an outcome for a prognostic model because of the low number of people off work at follow-up and, hence, limited clinical relevance in this population.

Patients scored their perceived recovery on a 6-point Likert scale, ranging from "completely recovered" to "much worse." The scale was dichotomized into "recovered" (completely recovered or much improved) and "not recovered" (slightly improved, no change, slightly worse, much worse). Pain was measured according to the Numerical Rating Scale (NRS), which ranges from no pain (0) to severe pain (10).[14,15] The scale was dichotomized into "no improvement in pain" and "improvement in pain," using a reduction of 33% at follow-up compared to the baseline value, as a clinically relevant difference.[16] Physical functioning was measured according to the Quebec Back Pain Disability Scale (QBPDS).[17,18] This scale ranges from 0 to 100, and a higher score indicates more disability. This scale was dichotomized, and a reduction of 15 points was considered to be clinically relevant.[19] The outcome "disabling low back pain" was defined as having both pain (>1 on the NRS) and disability (>25 on the QBPDS) at follow-up. The patients who had no pain and/or no disability were interpreted to be having no disabling low back pain.

**Prognostic Factors.** The following potential prognostic factors were evaluated: age, gender, duration of complaints at baseline (0–3 weeks/4–12 weeks/>12 weeks), prior back pain episode (yes/no), level of education (low/intermediate/high), having a paid job (yes/no), sickness insurance (private/public), baseline scores for pain (NRS),[14,15] physical functioning (QBPDS),[17,18] and beliefs (Back Beliefs Questionnaire).[20] Finally, coping (Pain Coping Inventory)[21] was used with 6 subscales: transforming, relaxation, lowering demands (all three active coping styles), withdrawing, catastrophizing, resting (all three passive coping styles).

**Statistical Analysis.** Differences in prognostic variables between respondents and nonrespondents at 12 months follow-up were calculated with Mann-Whitney tests for ordinal variables and *t* tests for linear variables. Because of the dichotomized outcomes, $\phi$ coefficient was used to calculate the association between outcome measures.

At 12-month follow-up, there were no differences in pain (NRS) and physical functioning (QBPDS) between the two intervention groups in the trial. The mean (SD) pain at 12 months was 2.5 (2.5) and 2.3 (2.3) for intervention and control group, respectively: the mean (SD) for functioning were 21.0 (19.8) and 18.8 (18.5).[9] Also the results at 3 months showed no intervention effect (data not shown). Therefore, the two groups were pooled for the purpose of this study.

Regression analyses were used to develop prognostic models, and all regression analyses were adjusted for the allocated intervention of the trial. Univariate logistic regression analyses were performed to examine the relationship between the outcome measures and each of the potential prognostic factors adjusted for the intervention. Significantly associated variables were subsequently included in a multivariate logistic regression model. Two methods were used to build the model: forward selection (LR-test $P_{\text{inclusion}} < 0.05$; $P_{\text{exclusion}} > 0.05$) and backward elimination (LR-test $P_{\text{removal}} > 0.1$; $P_{\text{inclusion}} < 0.05$). To assess whether the level of significance influenced the final prognostic model for all models, two separate *P* values were used to determine whether there was a univariate association: 0.05 and 0.20. As a result, a total of 32 prognostic models were constructed.

These models were compared with regard to the number and type of variables and odds ratios (OR), using $e^B$. To give an indication of the predictive power of the model, the percentage of explained variance (Nagelkerke's $R^2$) and the percentage of correctly classified patients were presented. The predicted probability for each subject is calculated using the parameters

**Table 1. Demographic and Baseline Characteristics of Patients With Low Back Pain Who Have Been Referred to the Physiotherapist (n = 500)**

| Demographic Variables | | Baseline Variables | Mean (SD) |
|---|---|---|---|
| Age: mean (SD) | 45.3 (14.1) | Sick-leave (% yes) | 44.8% |
| Gender (% female) | 51.8 | Pain (NRS 0–10) | 6.4 (2.1) |
| Duration current episode (%) | | Functioning (QBPDS 0–100) | 40.2 (18.3) |
| 0–3 wk | 33.3 | Beliefs (BBQ 9–45) | 30.6 (6.5) |
| 4–12 wk | 35.4 | Coping (PCI) | |
| >12 wk | 31.2 | Active coping sub-scales: | |
| Prior back pain episode (% yes) | 73.0 | Transforming (4–16) | 8.4 (2.5) |
| Education (%): | | Relaxation (5–20) | 11.4 (3.2) |
| Low | 26.4 | Lowering demands (3–12) | 6.7 (1.8) |
| Medium | 37.8 | Passive coping sub-scales: | |
| High | 35.7 | Withdrawing (7–28) | 10.6 (3.4) |
| Paid job (% yes) | 73.0 | Catastrophizing (9–34) | 16.8 (4.7) |
| Health insurance (% public) | 65.2 | Resting (5–20) | 11.3 (2.7) |

NRS = numerical rating scale; QBPDS = Quebec Back Pain Disability Scale; BBQ = Back Beliefs Questionnaire (a higher score represents "better" or less inevitably beliefs); PCI = pain coping inventory (a higher score indicates more active or more passive coping); low education = primary school or low vocational education; medium education = intermediate vocational education; high education = high vocational education or university.

of the multivariate model on a scale of 0 to 1. If this probability was >0.5, the patient was considered recovered. For each subject, the predicted outcome was compared with the actual observed outcome to determine the percentage of correctly classified patients. This percentage was compared with the prevalence of the outcome, which is the a priori chance to classify patients correctly. All analyses have been performed with SPSS version 10.0.

## ■ Results

### *Study Population*

During the 8-month enrolment period (May–December 2001), 500 patients were included in the study. Their baseline characteristics are presented in Table 1. The number of nonrespondents at 3 months was 52 (10.4%), and at 12 months it was 72 (14.4%). The average age of nonrespondents and respondents at 12 months was 46.2 years (SD 13.8) and 40 years (SD 14.4), respectively ($P = 0.001$), whereas all other prognostic variables showed no difference.

### *Prognosis*

Within the first 3 months, pain, functioning, and sick-leave improved considerably, with a small additional improvement in the period between 3 and 12 months (Table 2). After 12 months, 77.4% of the patients showed clinically significant improvement in pain, 57.5% showed improvement in physical functioning, and 72.9% had no disabling low back pain. At both 3 and 12 months about 75% of the patients perceived recovery. Correlations between the different outcomes are presented in Table 3. The strongest correlations involve perceived recovery at 12 months with both disabling low back pain and improvement in pain, both at 12 months.

### *Factors Predicting Prognosis*

Table 4 shows the multivariate models for improvement in pain and improvement in functioning at 12-month follow-up, which we considered as the most relevant outcomes for this population. The final model for improvement in pain (forward selection) consisted of two factors: duration of the current episode and pain intensity at baseline. These factors explained 10% of the variance and classified 77.1% of the patients correctly, which equals the percentage that could be classified correctly based on chance alone. The final model for improvement in functioning (forward selection) consisted of 3 factors: having a paid job, duration of the current episode, and functioning at baseline. These factors explained 28.3% of the variance and classified 73.4% of the patients correctly compared with 57.5% based on chance alone.

### *Changing Outcome*

Table 4 also presents multivariate models for three alternative outcomes. The model for perceived recovery at 12 months (forward selection) consisted of 2 factors: duration of the episode and having a paid job. The model for perceived recovery at 3 months (forward selection) con-

**Table 2. Prognosis of the Patients With Low Back Pain Who Have Been Referred to the Physiotherapist (n = 500)**

| | 3 Months | 12 Months |
|---|---|---|
| Pain (NRS 0–10) mean (SD) | 2.6 (2.4) | 2.4 (2.5) |
| Functioning (QBPDS 0–100) mean (SD) | 21.6 (18.3) | 19.9 (19.2) |
| Sick-leave* (% yes) | 9.7% | 7.3% |
| Perceived recovery (%) | 74.5% (n = 333) | 75.4% (n = 322) |
| Improvement in pain (% improved) | | 77.4% (n = 328) |
| Improvement in functioning (% improved) | | 57.5% (n = 244) |
| Disabling low back pain (% not disabled) | | 72.9% (n = 312) |

Note. Recovered: pain at least 33% reduced on NRS at follow-up compared with the baseline value; functioning at least 15 points on QBPDS improved compared with baseline value; disabling low back pain: not having pain (>1 NRS) nor disability (>25 on QBPDS); perceived recovery: completely recovered and much improved.
*One or more days taken off work because of low back pain in the previous 6 weeks.

**Table 3. Phi Coefficient Correlation Between Outcome Variables**

| | Perceived Recovery 12 Months | Improvement in Pain 12 Months | Improvement Functioning 12 Months | Disabling Low Back Pain 12 Months |
|---|---|---|---|---|
| Perceived recovery 3 months | 0.32* | 0.20* | 0.21* | 0.31* |
| Perceived recovery 12 months | | 0.57* | 0.42* | 0.62* |
| Improvement pain 12 months | | | 0.39* | 0.45* |
| Improvement functioning 12 months | | | | 0.42* |

*$P < 0.001$.

sisted of 3 prognostic factors: duration of the episode, transforming, and beliefs. The model for disabling low back pain (forward selection) consisted of 4 factors: duration of the episode, catastrophizing, age, and functioning at baseline. These models explained between 13.2 and 19.7% of the variance.

### *Changing Statistical Technique*

Using a $P < 0.2$ instead of $P < 0.05$, to determine whether there was a univariate association, resulted in the inclusion of a higher number of variables in the model, but without a substantial increase of variance explained in the final multivariate models (data not shown).

The use of backward elimination or forward selection identified different prognostic variables for some but not all outcomes. Although the OR for the same variables varies slightly between the two methods, it did not substantially change the variance explained in the final models. Table 4 presents three examples of the models, including two models with the most substantial changes. Overall, the models with backward selection consisted of an equal number or more variables and had an equal or slightly higher percentage of variance explained.

## ■ Discussion

The prognosis of patients with low back pain who are referred to physiotherapy shows similar characteristics compared with the prognosis of patients in a general practice setting; a substantial improvement within the first 3 months is followed by a modest further improvement after 12 months. However, after 12 months, patients experience more pain and more problems with functioning,[2] suggesting that the population, as hypothesized, has a worse outcome compared with a general primary care population.

Overall, we found four prognostic factors for improvement of pain or functioning at 12 months: the duration of the current episode, having a paid job, and pain or functioning, respectively, at baseline. In addition, this study showed that predominantly the outcome measures and duration of follow-up affected the prognostic factors and its percentage of explained variance. In general, the prognostic models classified a high percentage of patients correctly, but they explained only a low percentage of variance.

This study has been performed within the framework of a RCT. The intervention (*i.e.*, the implementation strategy), was considered as a potential confounder and was corrected for in all analyses. It should be noted that an RCT has a potentially lower external validity for prognostic research questions compared with population-based cohort studies.[22]

In this RCT, the physiotherapists did not select patients other than those with nonspecific low back pain,

**Table 4. Results of the Forward Selection and Backward Elimination Regression Analysis With Various Outcome Variables**

| Outcome | Improvement in Pain at 12 Months | | Improvement in Functioning at 12 Months | | Disabling Low Back Pain at 12 Months | | Perceived Recovery at 3 Months | | Perceived Recovery at 12 Months | |
|---|---|---|---|---|---|---|---|---|---|---|
| Multivariate; Forward selection | Duration episode | 1.99 | Paid job | 3.01 | Duration episode | 1.69 | Duration episode | 2.53 | Duration episode | 2.34 |
| | Pain | 1.14 | Duration episode | 1.62 | Catastrophizing | 1.08 | Transforming | 1.13 | Paid job | 1.82 |
| | | | Functioning | 1.06 | Age | 1.03 | Beliefs | 1.06 | | |
| | | | | | Functioning | 1.03 | | | | |
| Explained variance | | 10.0% | | 28.3% | | 19.7% | | 18.6% | | 13.2% |
| % correctly classified | | 77.1% | | 73.4% | | 74.8% | | 75.0% | | 75.4% |
| Multivariate; Backward elimination | | | Paid job | 2.16 | Duration episode | 1.69 | Duration episode | 2.53 | | |
| | | | Duration episode | 1.70 | Catastrophizing | 1.08 | Education | 1.35 | | |
| | | | Pain | 1.14 | Age | 1.03 | Lowering demands | 1.13 | | |
| | | | Functioning | 1.06 | Functioning | 1.03 | Transforming | 1.11 | | |
| | | | Age | 1.02 | | | Beliefs | 1.05 | | |
| Explained variance | | | | 30.3% | | 19.7% | | 20.5% | | |
| % correctly classified | | | | 74.4% | | 74.8% | | 75.7% | | |

Note. Only variables, associated with the outcome ($P < 0.05$) were candidate variables for the multivariate regression. For each variable, the OR is presented.

and there was no difference in patient outcome between usual care and care after an active implementation strategy for guidelines. This suggests that the results could be valid for a general population. In addition, an advantage of our RCT is that a large variety of outcomes have been measured and that 85% of all patients were observed for up to 12 months. This makes it possible to compare the outcomes and their prognostic factors to investigate the underlying mechanisms of a poor outcome.

### *Prognostic Models for Low Back Pain*

In general, we were unable to generate a very good prognostic model. A reason for the lack of a good prognostic model could be the relatively high prevalence of good outcomes (*i.e.*, many patients showed considerable improvements in the first 12 weeks). It may be very difficult to find prognostic factors, which can predict over and above this rather favorable course. Other reasons may be that we have not measured the adequate prognostic factors for this population, such as job dissatisfaction or somatization. Finally, also overfitting of our model or including too many variables in the model may partly explain some of the inconsistencies. Overfitting makes a model less stable and less generalizable. A rule of thumb to calculate the maximum number of variables is dividing the smallest number of patients in an outcome category by 10.[23]

The most consistent prognostic factor was the duration of the current episode, as previously suggested.[11,13,24] Duration of the current episode retained in each prognostic model. The second most consistent prognostic factor was having a paid job. Persons without a paid job have almost a three times higher risk not to recover on functioning, whereas there is no association with recovery on pain. Also, the data suggest that the factor of having a paid job is mainly related to long-term outcomes.

Potter[12] showed that the intensity of pain at baseline, a previous episode of continuous pain and an active coping score were related to pain at 3 months. We found an association between recovery in pain and intensity of pain but not with active coping, which confirms previous work by Carroll *et al*[25] in a study on patients with back and neck pain. They reported that high levels of passive coping were associated with disabling pain. In our study catastrophizing, a passive coping strategy, was prognostic for disabling low back pain. This might indicate that changing passive coping strategies needs to get priority in treatment, as well as in primary care.

Comparing the models for improvement in pain, improvement in functioning, and disabling low back pain gives insight in the relation between pain and functioning. The results suggest that functioning is a more important factor for recovery than pain, because functioning is the only factor predicting disabling low back pain. This fits well with an important management principle in low back pain, which is to restore the patient's functioning as soon as possible.

### *Changing Outcome*

The finding that the models varied for the different outcomes fits with the earlier statement that it is likely that there are different underlying mechanisms for the different outcomes for low back pain.[6] We have assessed four different outcomes, which seemed most relevant for our population. A limitation of our study has been not to include return to work as outcome, because a previous prognostic study suggested both an interaction between workplace-related outcomes and change in pain and an attenuation in the ability of clinical factors (*e.g.*, pain and functioning) to predict outcomes past the eighth week.[26] However, our population did not consist of workers on sick leave because of back pain but of primary care patients who visited a physiotherapist because of low back pain.

Because the outcomes revealed different prognostic factors, and there are only moderate correlations between the outcomes, these should be considered as complementary. The perceived recovery at 3 months has the lowest correlation with all outcomes at 12 months, and pain or disabling low back pain with perceived recovery shows the highest correlation. This may reflect the importance of relieving pain from the perspective of patients. Interestingly, this seems to contradict the above mentioned results of the regression analysis (*i.e.*, functioning is more important for recovery than pain). This illustrates an important bottleneck of implementing evidence into clinical practice. According to the evidence, physiotherapists should primarily focus on improving functioning because there is no evidence that any intervention improves the reduction of pain. Patients, however, may expect a treatment to be primarily aimed on the reduction of pain. Patient expectations should therefore be examined carefully to optimize treatment outcome.

### *Changing Statistical Techniques*

The backward elimination starts with a model that contains the largest number of variables and removes variables with the lowest multivariate association one at a time. This method may be used for retaining just a small number of variables for the model,[13] which is often the goal when making a prognostic model. However, our study showed that more often the forward selection method had the smallest number of remaining variables. To generate the best prognostic model, it is therefore recommended to explore both selection methods and to choose the model with the highest level of prediction. If both approaches lead to a similar level of prediction, the obvious choice is the model with the lowest number of variables. In general, changing statistics of a prognostic study could reveal other prognostic factors, which could contribute to explaining the differences in prognostic factors between the various studies in low back pain. However, it is unlikely that this influences the amount of explained variance. In addition, clinical insight is always

needed for each modeling study to check if the prognostic factors make any sense.

### *Implications*

In summary, the most robust predictor of the prognosis in low back pain is the duration of the current episode. Although the current management trend is a wait-and-see policy, this could suggest that waiting too long before referring to the physiotherapist may increase the risk of a poor outcome. According to current evidence, physiotherapy treatment for low back pain should primarily use active interventions and focus on restoring activities.[27] Future studies on the prognosis of low back pain should present data on the predictive power of the model. With regard to logistic regression techniques, it is recommended that a low cut-off value is used to determine association in the univariate analyses and both forward selection and backward elimination are used to identify the best predictive model. As the choice of statistical method influences the final model, this should be clearly described in future prognostic studies.

### ■ Key Points

- We described the prognosis of patients with low back pain who were referred to physiotherapy and compared the results of different outcomes and variants of logistic regression modeling for identifying prognostic factors.
- Pain and disability reduces considerably in the first 3 months, but further reduction was only modest. A substantial proportion of patients still experienced some pain and disability at 12-month follow-up.
- Prognostic factors varied for different outcomes. Varying the statistical techniques also resulted in a different prognostic model with some change to the amount of variance explained.
- The most robust prognostic factor in low back pain is the duration of the current episode.
- The results of this study suggest that waiting too long before referring to the physiotherapist may increase the risk of a poor prognosis.

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